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Developments and applications of adaptive-focus liquid crystal lenses

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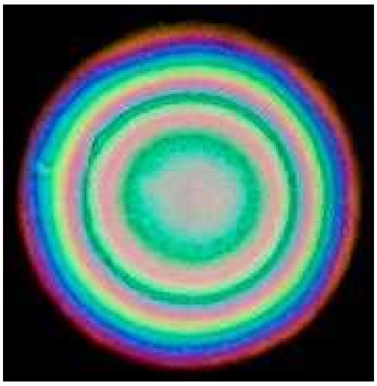
Liquid crystals (LCs) offer unique advantages to optical lens design. Rather than shaping fixed-focus lenses from solid optical materials of constant refractive index, LC lens cells of constant thickness but variable refractive index can be fabricated. These have the advantage of having electrically controllable and switchable focal lengths, without the need for heavy and power-consuming electro-mechanical positioning systems. This makes them ideal for compact and lightweight imaging applications, such as mobile phone cameras, or aircraft and space-based optical systems. They also offer opportunities for aberration correction in applications such as ophthalmics and adaptive optics for astronomy.

In this presentation, a comparison of several different approaches to LC lens technology is presented, including: fringing-fields microlens arrays[1] for integral imaging techniques (including a 3D microscope[2]); zonal-addressing with pixelated electrodes,[3] and modal-addressing with frequency and voltage control of lens index profile.[4, 5] Fast-switching hybrid birefringent lenses are also presented,[6] which use ferroelectric LCs to rapidly modulate input polarisation; the fast-response of which enables their implementation in next-generation adaptive focus (volumetric) 3D display systems.[7]



(*Left*) Concentric inference fringes from a modal LC lens, and (*right*) a fast-switching 3D display lens system[7]

References:

1. T. Nose and S. Sato, Liquid Crystals **5** (5), 1425-1433 (1989).
2. R. Rajasekharan, T. D. Wilkinson, P. J. W. Hands and Q. Dai, Nano Letters **11** (7), 2770-2773 (2011).
3. L. Li, L. Shi, D. Bryant, T. Van Heughten, D. Duston and P. J. Bos, Proc. SPIE **79440S** (2011).
4. A. F. Naumov, M. Y. Loktev, I. R. Guralnik and G. V. Vdovin, Optics Letters **23** (13), 992-994 (1998).
5. P. J. W. Hands, G. D. Love and A. K. Kirby, Proc. SPIE **5188**, 136-143 (2004).
6. A. K. Kirby, P. J. W. Hands and G. D. Love, Proc. SPIE **6018**, 14 (2005).
7. G. D. Love, D. M. Hoffman, P. J. W. Hands, J. Gao, A. K. Kirby and M. S. Banks, Optics Express **17** (18), 15716-15725 (2009).